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Tests of Capacity of Deep Well Strainers

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TESTS OF CAPACITY OF DEEP WELL STRAINERS

BY

N RAYMOND PORTERFIELD

THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

PRESENTED JUNE, 1906

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May 29, 1906

This is to certify that the following thesis prepared under the direction of Professor A. N. Talbot, Head of the Department of Theoretical and Applied Mechanics, by

N RAYMOND PORTERFIELD

entitled TESTS OF CAPACITY OF DEEP WELL STRAINERS

is hereby approved by me as fulfilling this part of the requirements for the Degree of Bachelor of Science in Civil Engineering.

Ira O. Baker

Head of Department of Civil Engineering

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Tests of the Capacity of Deep Well Strainers.

There is no published information giving the capacity of well strainers. The writer therefore hopes that the data he presents in this thesis will be useful to those who have to select strainers for tubular wells.

Tests were made to determine the discharge, under given heads, through the well strainers, (a) with sand from the water bearing stratum of the University of Illinois well No 4 around the strainer, and, (b) with no sand around the strainer. The heads of water used were respectively 10, 20, and 30 feet.

Plate 1 p. 10 shows the arrangement of the strainer and sand in the water tight box. The velocity of the water through the sand at a distance of 8 inches from the strainer, for any ordinary flow may be shown by computation to be negligible. The head lost in friction and the velocity head will be correspondingly low, and a layer of greater thickness than 8 inches was considered unnecessary.

The details of the water tight box are shown on plate 2 p. 11. The strainer is

inverted and screwed into a flange in the bottom of the box. The end of the strainer is plugged so all of the water must pass through the strainer openings. The box was built so that the top and front could be removed. The strainer and sand could be changed easily when one side was taken off.

Water was admitted to the box through a 3 inch inlet pipe. The water surrounded the cylinder of sand and flowed through the sand and strainer. The sand was held in place by wire netting.

The strainers tested were the Cook and the American Well Works type. A Johnson strainer was ordered, but was not received. The Cook strainers are $2\frac{3}{4}$ inches outside diameter, and have 2 feet of openings. One was No 6 cut, one No 10, and one No 20. The details of these strainers are shown on plate 3 p.12. The American Well Works strainer was made by covering a 3 inch iron pipe, which had 6 rows of 12 holes each with a diameter of $\frac{1}{2}$ inch, with copper gauze. This gauze is separated from the pipe by a coarse wire netting, and is held in place by three longitudinal galvanized iron strips riveted to the iron pipe.

The sand used in the tests was taken from the water bearing stratum of the University

well No 4. The vein lies about 140-145 feet below the surface of the ground. An analysis of the sand showed it to have a small per cent of very fine sand, and a low uniformity coefficient. Table I shows the separation size (in mm and inches) ie. the diameter of the largest sphere which will pass through the sieve. The table also shows the per cent of sand retained and the percent passing each sieve.

TABLE I

Mechanical Analysis of Sand from Vein of University Well No 4.

Sieve No.	Separation Size.		Per cent by Weight.	
	m.m.	inches	Retained	Passing
5	4.417	.174	2.5	97.5
10	2.32	.0914	5.4	94.6
12	1.699	.0669	6.2	93.8
18	1.08	.0425	8.0	92.0
30	0.684	.0269	10.7	89.3
40	0.49	.0193	16.5	83.5
50	0.324	.01274	61.8	38.2
74	0225	.00886	83.1	16.9

It is of interest to compare the percents passing the different sieves with that which passes through the strainers with different sizes of openings. Table II shows the per cents of dry

sand which will pass through the Cook strainers when they are used as sieves. Plate 4 p. 13 shows the arrangement for sifting the sand through these strainers.

TABLE II

Per cents of University Well No 4 Sand Passing and Retained by Cook Strainers. (Dry Sand)

	Cook Strainers		
	No 6	No 10	No 20
o/o Passing.	5.8	70.0	90.4
o/o Retained.	94.2	30.0	9.6

Plate 5 p. 14 shows the results of the mechanical analysis of the sand, the approximate separation size of the slits of the different strainers, and the actual width of the slits in millimeters. The strainers were used as sieves and the results in Table II are for dry sand. Very little of the sand will be carried through the openings of the strainers by the water, when compact.

Preliminary tests showed that the sand would settle 2 or 3 inches when put in loose, and thus uncover some of the openings at the upper end of the strainer. To avoid this the sand, in each test, was tamped in layers and brought to the level of the end of the strainer. It was then covered with

a board to prevent the inflowing water from washing the sand from around the strainer. The sand when packed in is probably more like the sand in the vein, than if put in loose.

The box was closed as soon as it was loaded, the water was turned in, and a constant head was maintained throughout each test. The latter was accomplished by using a 3 inch gate valve as a throttle. The water passing through the strainer in a given length of time was caught in a tank on scales and the rate of discharge was computed from the weight and the duration of the test. The discharge for alternate 5 minute periods was taken.

Plates 6, 7, 8, 9, & 10 show the amount and variation of discharge under the different heads, through the Cook strainers No 6, No 10, and No 20, and the American Well Works strainer.

Tests were made in the same way on the same strainers when not in sand. Plate 11 p 20 shows the results of these tests.

A study of the data shown on Plates 6, 7, 8, 9, 10, & 11 shows:

(a) That even with a constant head, the rate of discharge through the sand and strainer varies. These variations in the rate of discharge are gradual, and an hour or two are required to pass from a minimum to a maximum flow.

The variations in the rate of discharge are less marked in the low than in the high heads. The flow becomes constant with the low heads sooner than with the high heads. It is probable that the variations in flow are due to the shifting of the sand in the layers around the strainer. Finally the fine sand may be all permanently lodged or carried away, and the flow become constant.

(b) That an increase of head gives an increase in the rate of flow. There are too few data from which to get an exact relation. However the values are compared on the basis of one hour intervals, and it is probably safe to say, (1) that a coarse strainer is more readily effected by a change of head, (2) that the discharge increases at least as fast as the increase of the head, (3) that the rate of flow through the plain strainer varies about as the square root of the head.

(c) That after a period of rest the flow, for any head, will be greatest immediately on starting, and decreases for nearly the first hour. This may not be true of wells, as the water drains out of the sand in the box.

(d) That about 150-200 times as much water flows through the strainers with no sand, than when sand surrounds the strainer.

Selection and Use of a Deep Well Strainer

A strainer need not be longer than the water bearing stratum is thick if it can be exactly placed in the vein. Usually one or two feet are allowed for inaccuracy in placing, and unknown variations in the thickness of the vein.

The length of a strainer to give a flow equal to the capacity of the pipe which takes water from it, can hardly be determined. The rate of flow through the strainer depends on the head, the porosity of the sand, and other factors. Therefore the length will usually depend on the thickness of the vein.

The capacity and effectiveness of a strainer depends somewhat on its diameter, (1) there is a larger area of openings exposed to the water, (2) the same yield from a large diameter requires less velocity through the sand next to the strainer, and hence there is less head lost. The currents around a large strainer for the same yield are not so apt to carry the sand, and to lodge the grains across the strainer openings.

The results of the tests on the Cook strainers show that the rate of flow is materially greater through the No 20 cut than through the No 10 or No 6.

It will be usually best to select a strainer with large openings, and let the fine sand go into the well, than to have it lodge on the outside of the strainer. When lodged on the outside, the strainer openings are obstructed and the waterway through the sand is contracted.

It may be advantageous to take an amount of sand from the waterbearing stratum sufficient to loosen the sand for a considerable distance from the strainer. Care should be taken that clay and other material does not cave in to the opening from above.

If a coarse strainer is selected there will be a quantity of fine sand which will come into the well. This may be fine enough to be carried up with water being pumped. Under these conditions the well should be pumped continuously until the sand is all taken out. If the fine sand is allowed to settle, it may in time fill the strainer and cannot be dislodged except with a drill or water jet. A pocket may be placed below the strainer in which sand may collect. This will prevent the strainer being filled either by fine sand in intermittent pumping, or by coarser sand when the currents are too weak to carry this sand upward.

Table -III- shows the discharge in gallons per minute reduced to one square foot of strainer surfaces. The values were taken from the curves and show the discharge after test had been running one hour, two hours, and three hours.

TABLE -III-

Discharge in Gal. per Min., per sq. ft. of Strainer Surface, under different Heads.†

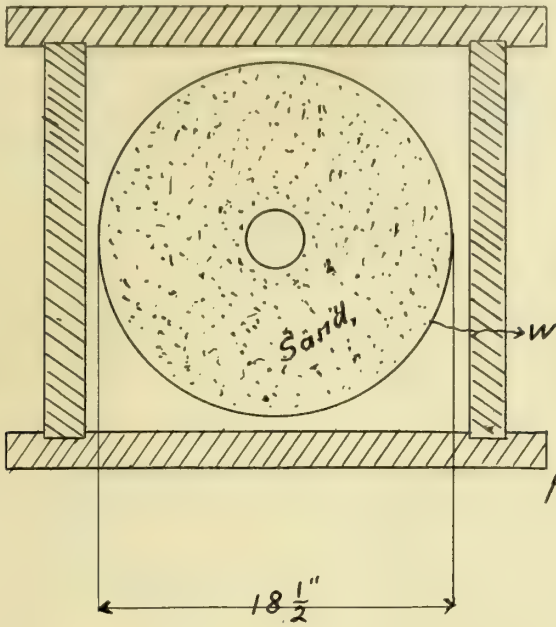
Head in feet.	Hours of Running	Cook Strainers			A.W.W.
		No 6	No 10	No 20	
10	1	.47	.35	✱ .90	.70
	2	.28	.35	✱ .76	60
	3	.25	.35	✱ .75	.60
20	1	.57	.97	✱ 2.10	1.28
	2	.44	.90	✱ 270	1.20
	3	.43	.90	✱ 4.35	1.20
30	1	.76	2.08	2.90	2.70
	2	1.25	3.40	6.30	4.25
	3	1.59	3.88	10.60	5.20

✱ In place of 10 & 20 ft. heads, the actual heads were 12 & 22 ft.

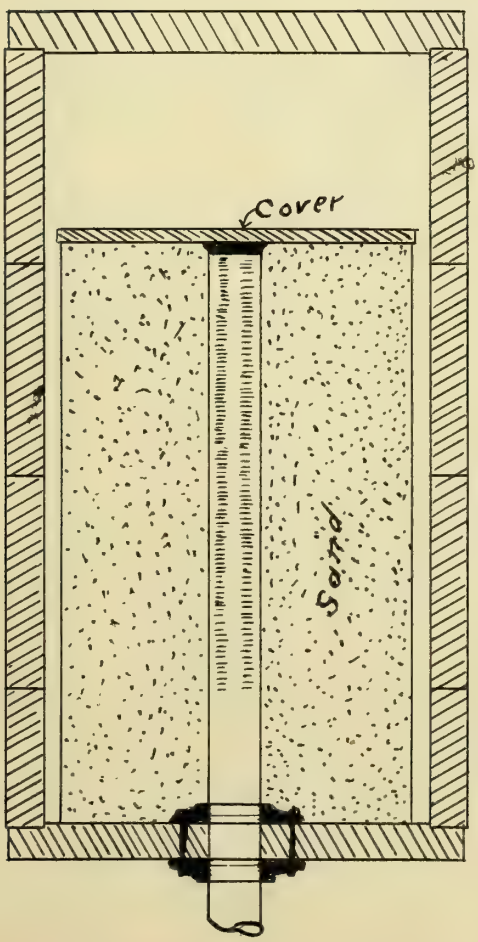
† With sand around the strainer.

PLATE I

Arrangement of Sand and Screen in Box.



Horizontal Section



Vertical Section.

PLATE-2.

FRONT, SIDE, & TOP VIEWS OF WATER-TIGHT BOX.

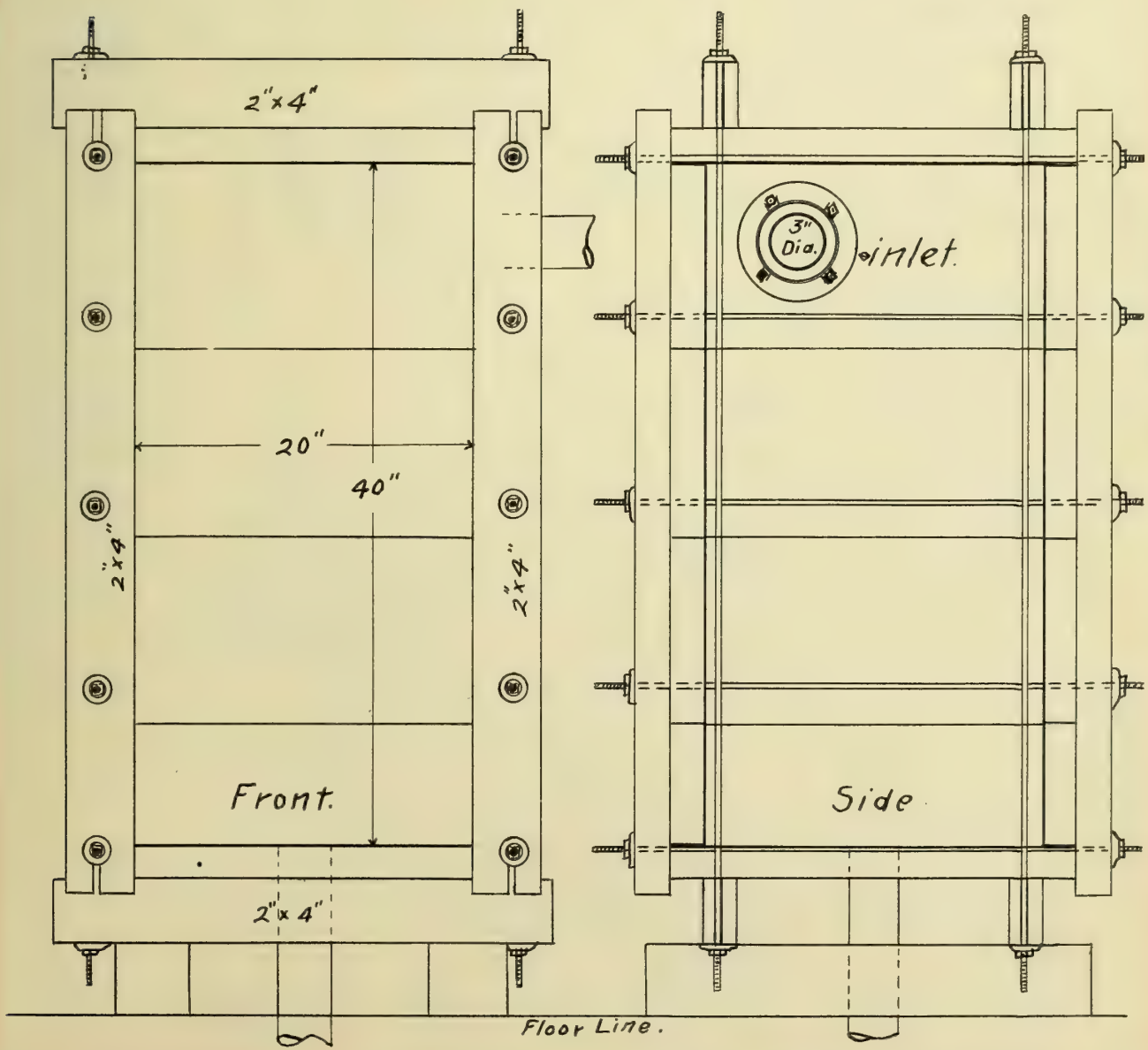
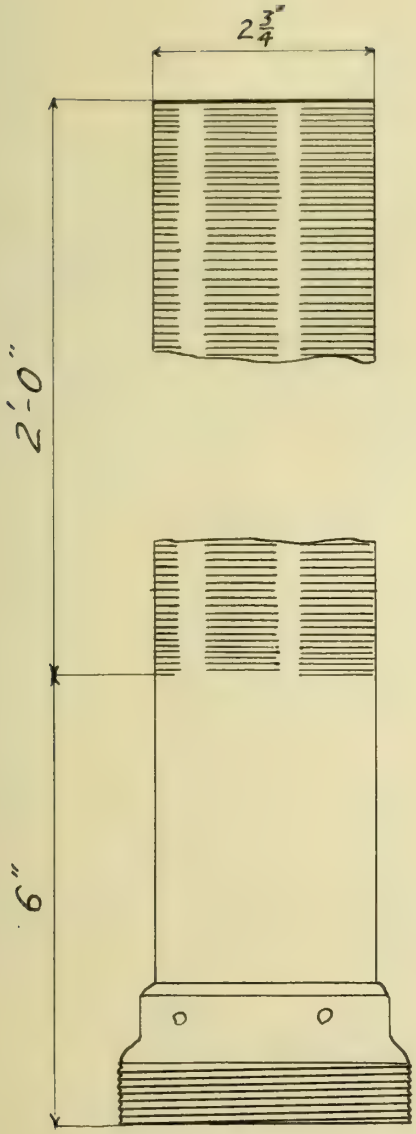


PLATE-3.



COOK STRAINERS

5 rows of openings.

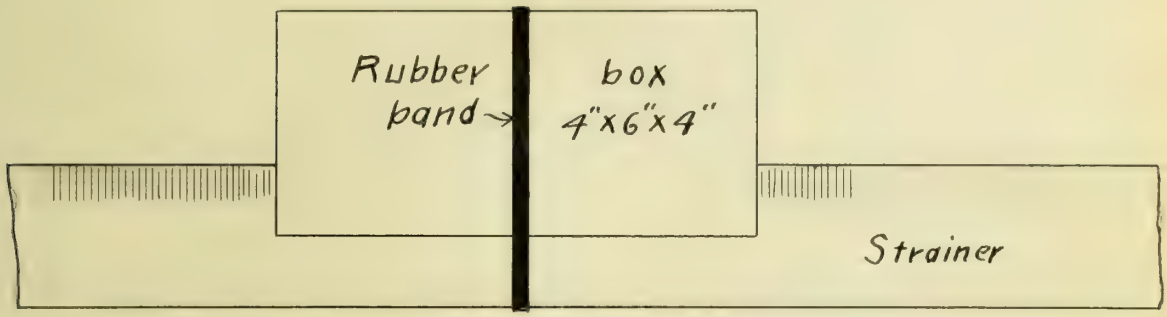
Each row 2'-0" long

1⅛" wide.

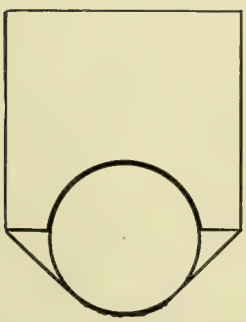
Each contains 144 slits.

Strainer –	Width of slits
No. 6	.10 m.m.
No. 10	.24 " "
No. 20	.57 " "

PLATE-4.



SIDE VIEW.



END VIEW.

VIEWS
showing
ARRANGEMENT of BOX
FOR SIFTING SAND
through COOK STRAINERS.

PLATE 5

DEPT OF MUN. AND SAN ENG. — UNIVERSITY OF ILLINOIS

MECHANICAL ANALYSIS OF SAND

Test No.

Sample from Well No. 4 University of Illinois.

Analyzed by N R. Porterfield.

Date of collection

Date of analysis March. 20, '06.

Remarks Sand taken from the water bearing stratum.

Amount Analyzed = 1000 grams

Sieve No	Separation Size mm	Amount Passing	
		Grams	Per cent
5	4.417	97.5	97.5
10	2.320	946	94.6
12	1.699	938	93.8
18	1.080	920	92.0
30	0.684	893	89.3
40	0.490	835	83.5
50	0.320	382	38.2
74	0.225	169	16.9

Effective Size .175 mm. Uniformity Coeff = 2.2

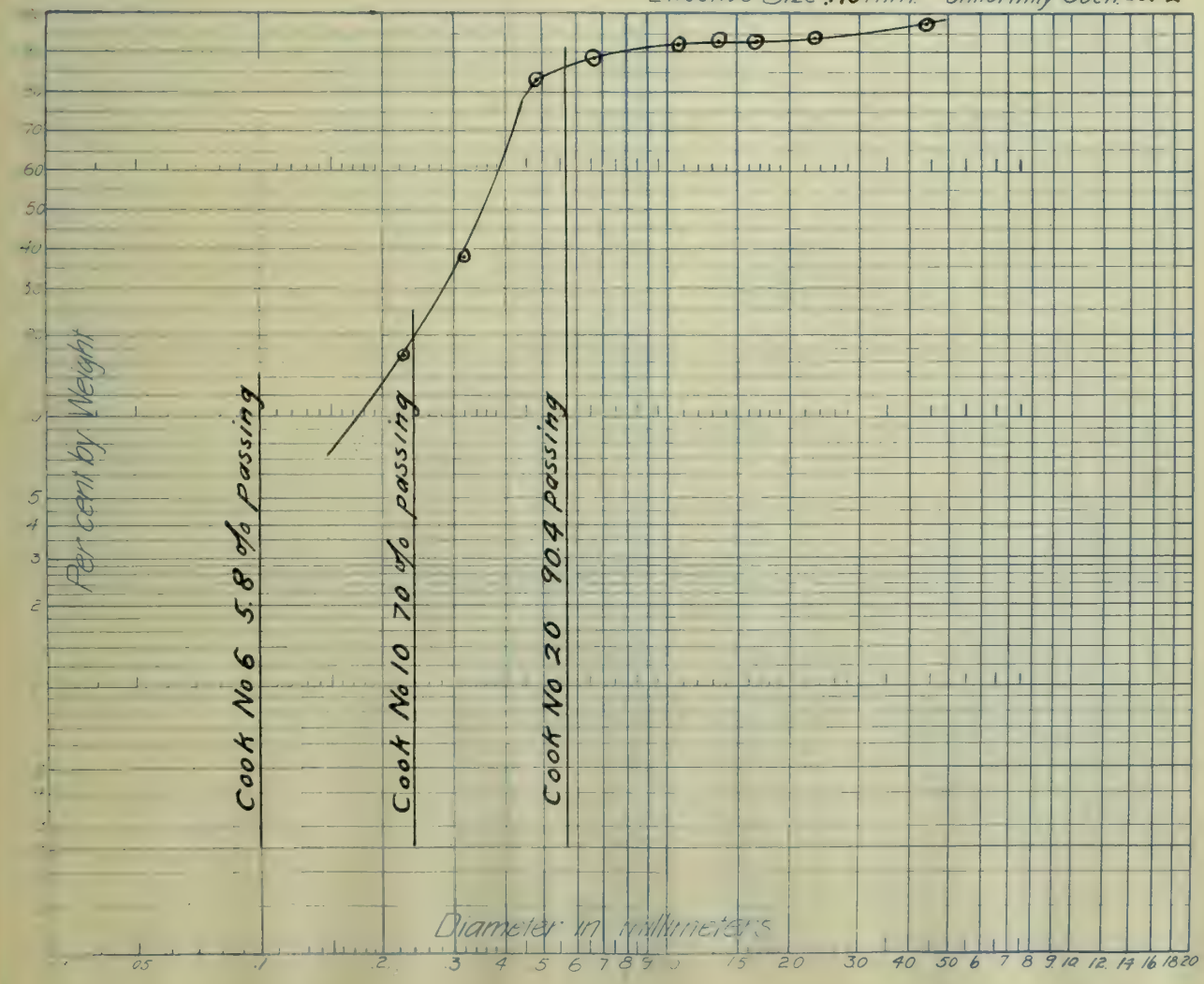


PLATE 6

CURVES

showing

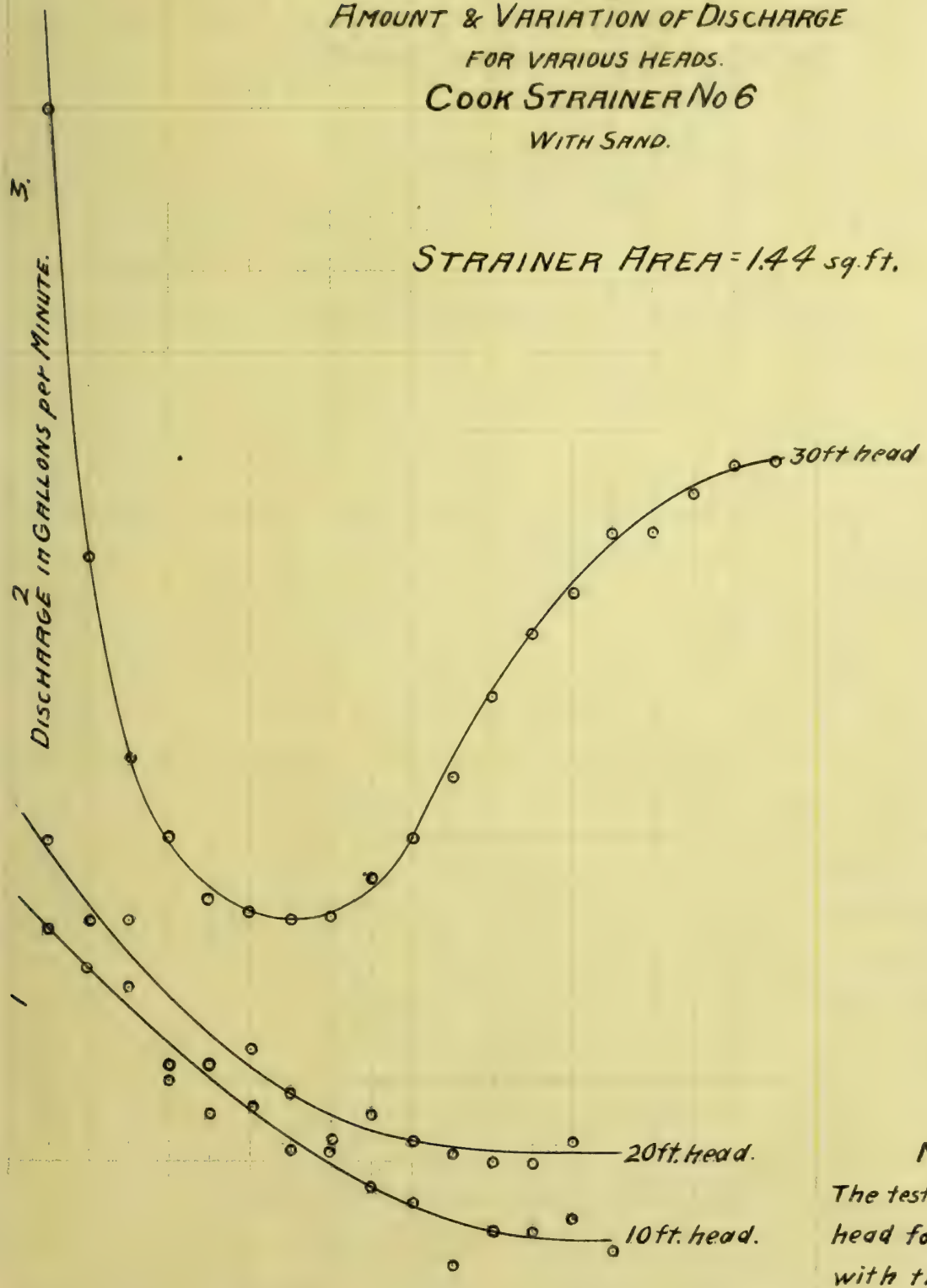
AMOUNT & VARIATION OF DISCHARGE

FOR VARIOUS HEADS.

COOK STRAINER No 6

WITH SAND.

STRAINER AREA = 1.44 sq. ft.



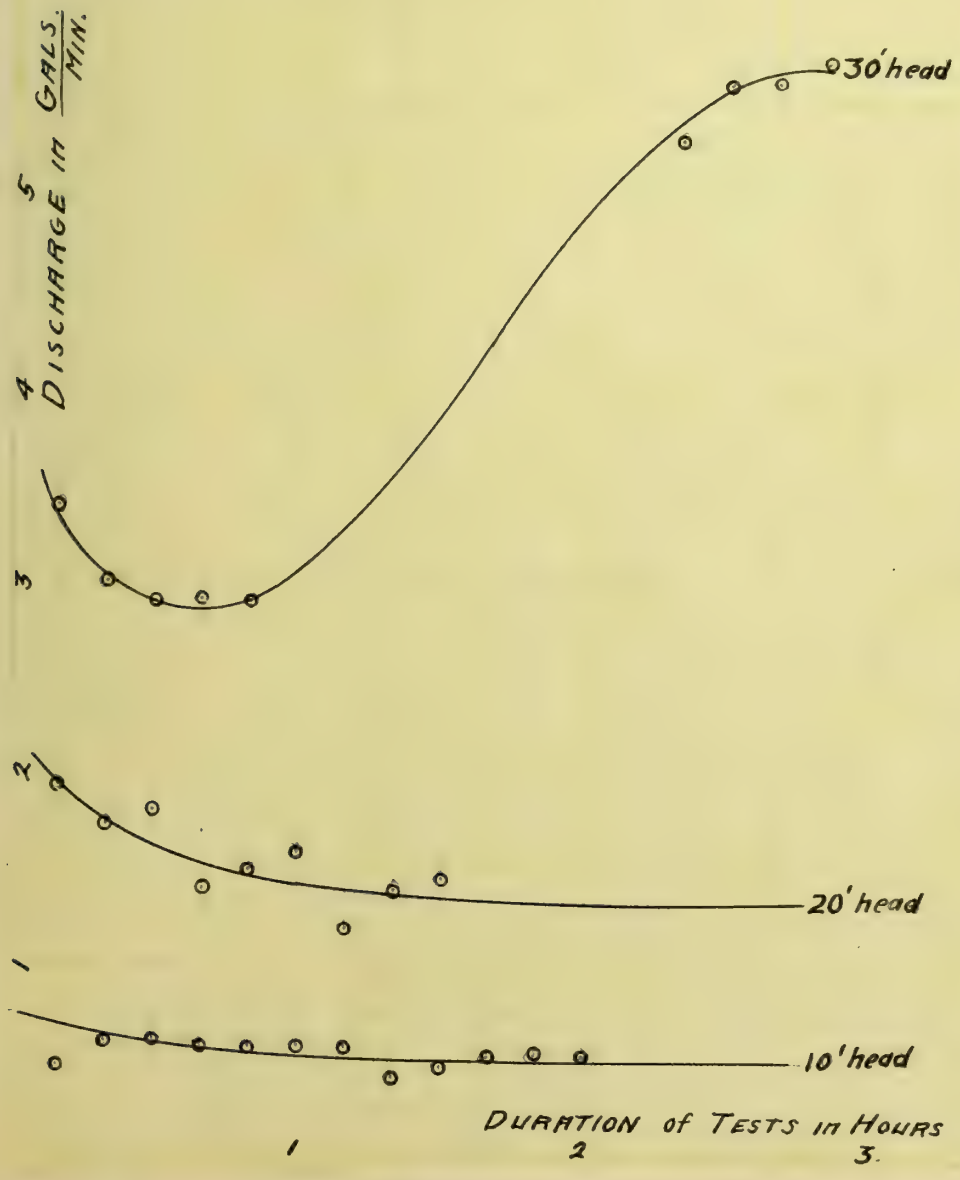
NOTES

The tests with the 20ft. head followed those with the 10ft. head. Two days elapsed before testing with the 30ft head.

PLATE 7

CURVES
showing
AMOUNT & VARIATION OF DISCHARGE
FOR VARIOUS HEADS
COOK STRAINER No 10
WITH SAND

STRAINER AREA = 1.44 sq. ft.



NOTES

The 10' & 20' head tests occurred one after the other The water was kept running at a low head and the next day the 30' head test was made.

PLATE-8

CURVES

SHOWING

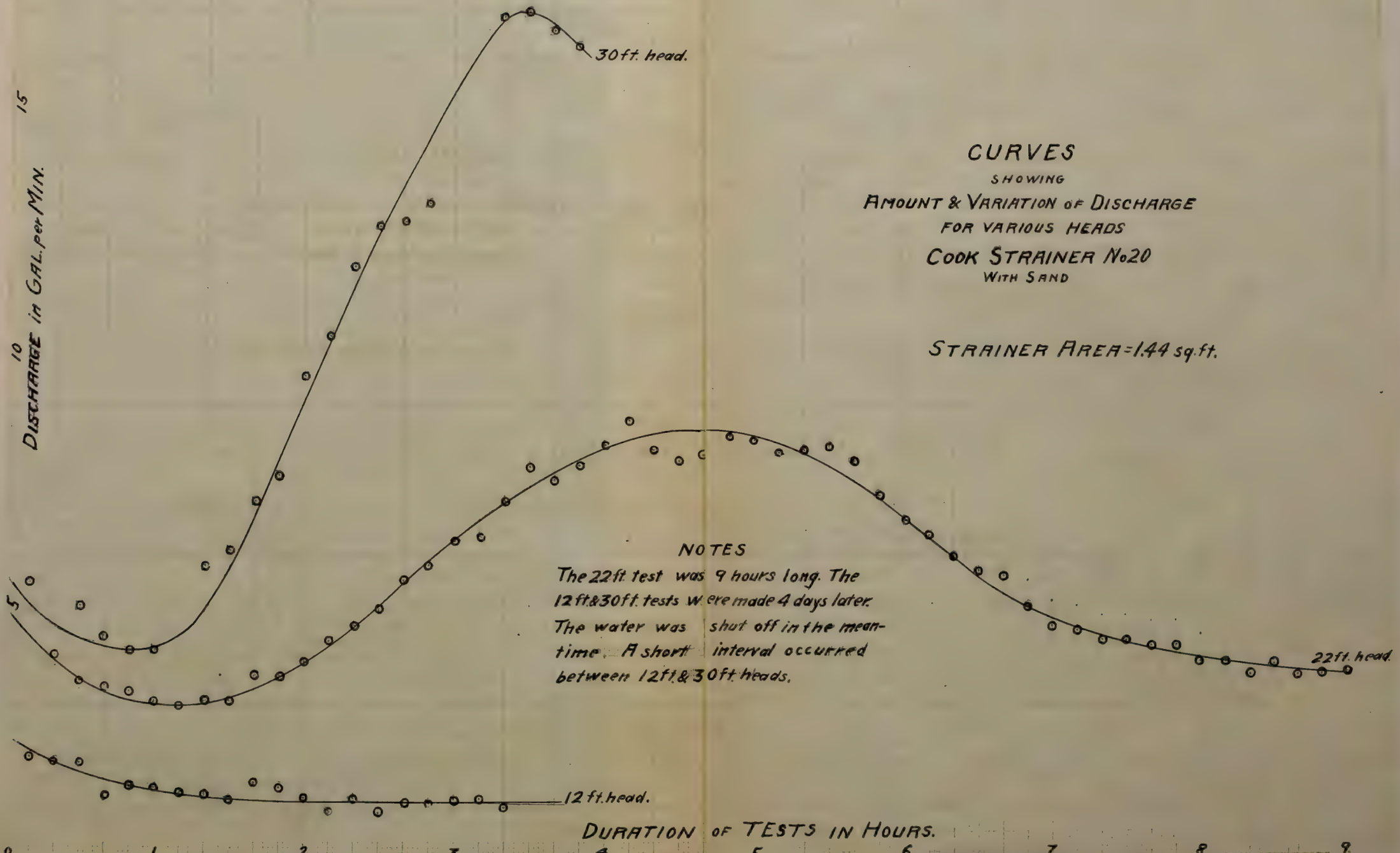
AMOUNT & VARIATION OF DISCHARGE

FOR VARIOUS HEADS

COOK STRAINER No.20

WITH SAND

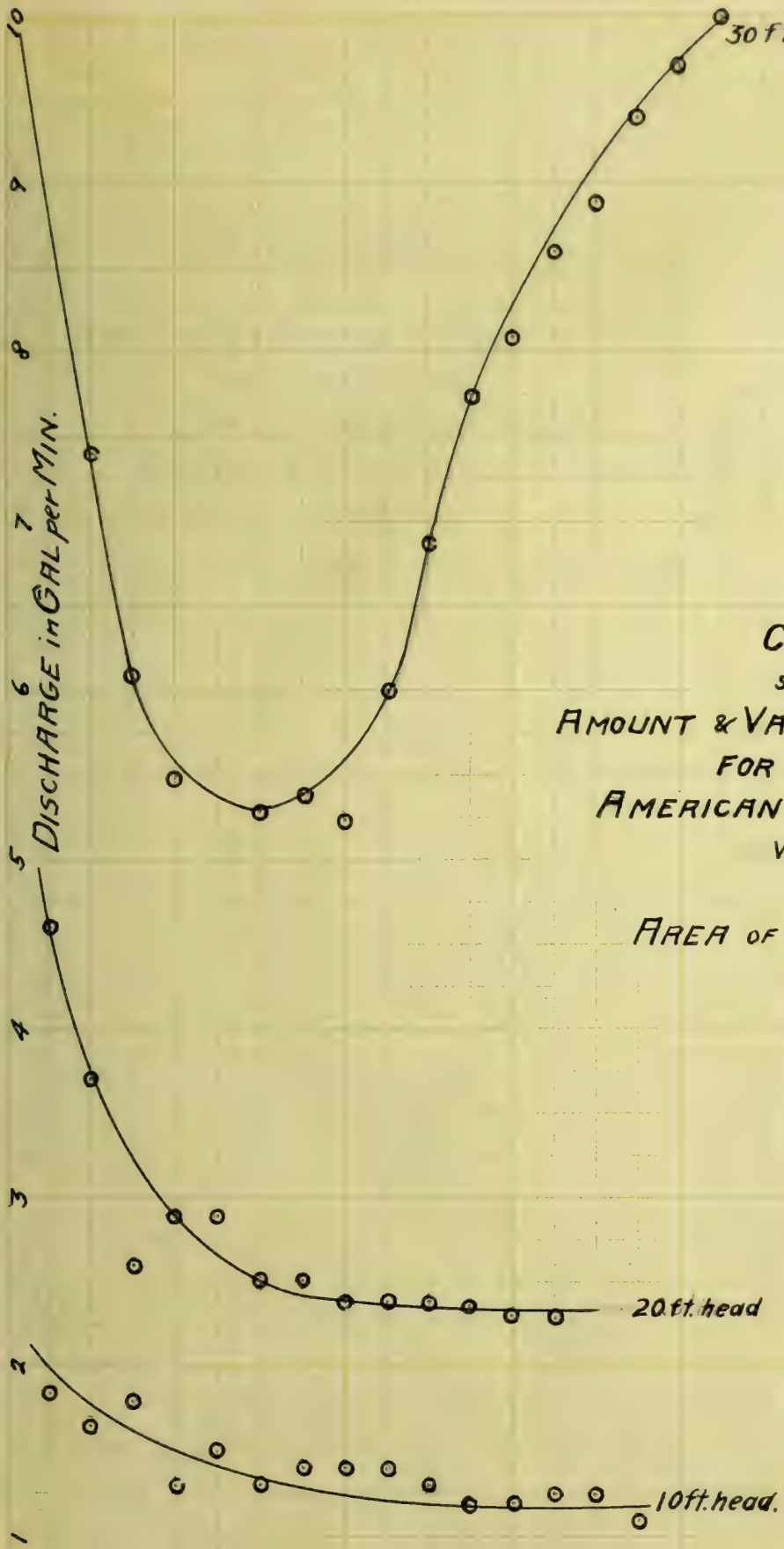
STRAINER AREA=1.44 sq.ft.



NOTES

The 22ft. test was 9 hours long. The 12ft. & 30ft. tests were made 4 days later. The water was shut off in the meantime. A short interval occurred between 12ft. & 30ft. heads.

PLATE 9



CURVES
showing
AMOUNT & VARIATION OF DISCHARGE
FOR VARIOUS HEADS
AMERICAN WELL WORKS STRAINER.
WITH SAND

AREA of STRAINER SURFACE = 1.96 □'

NOTES

Each test occurred on a different day. The water was shut off between tests.

EUGENE DIETZGEN CO., CHICAGO.

PLATE 10

CURVES
showing
AMOUNT & VARIATION OF DISCHARGE
FOR VARIOUS HEADS
COOK STRAINERS Nos 6, 10 & 20.
AMERICAN WELL WORKS STRAINER.
WITH SAND.

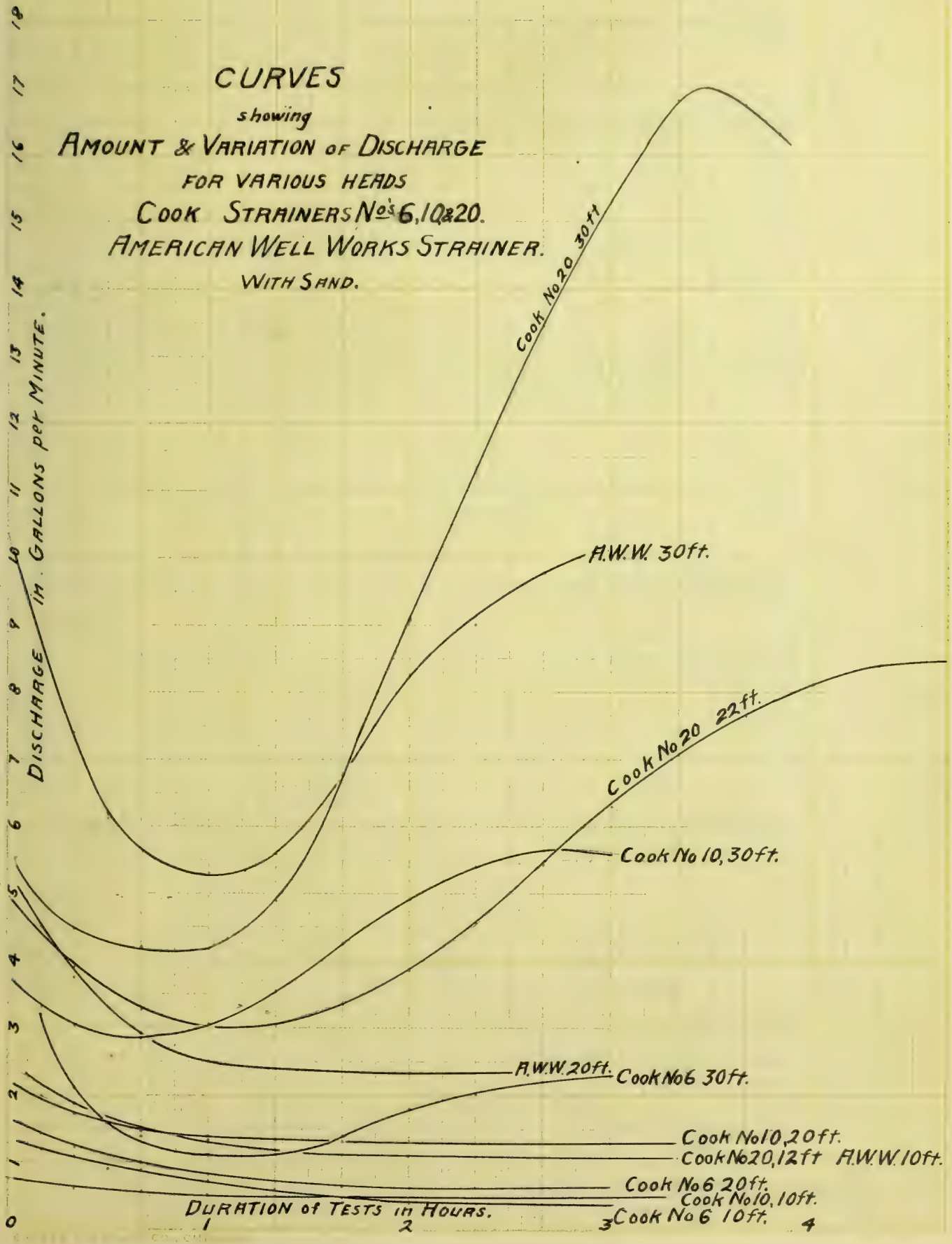
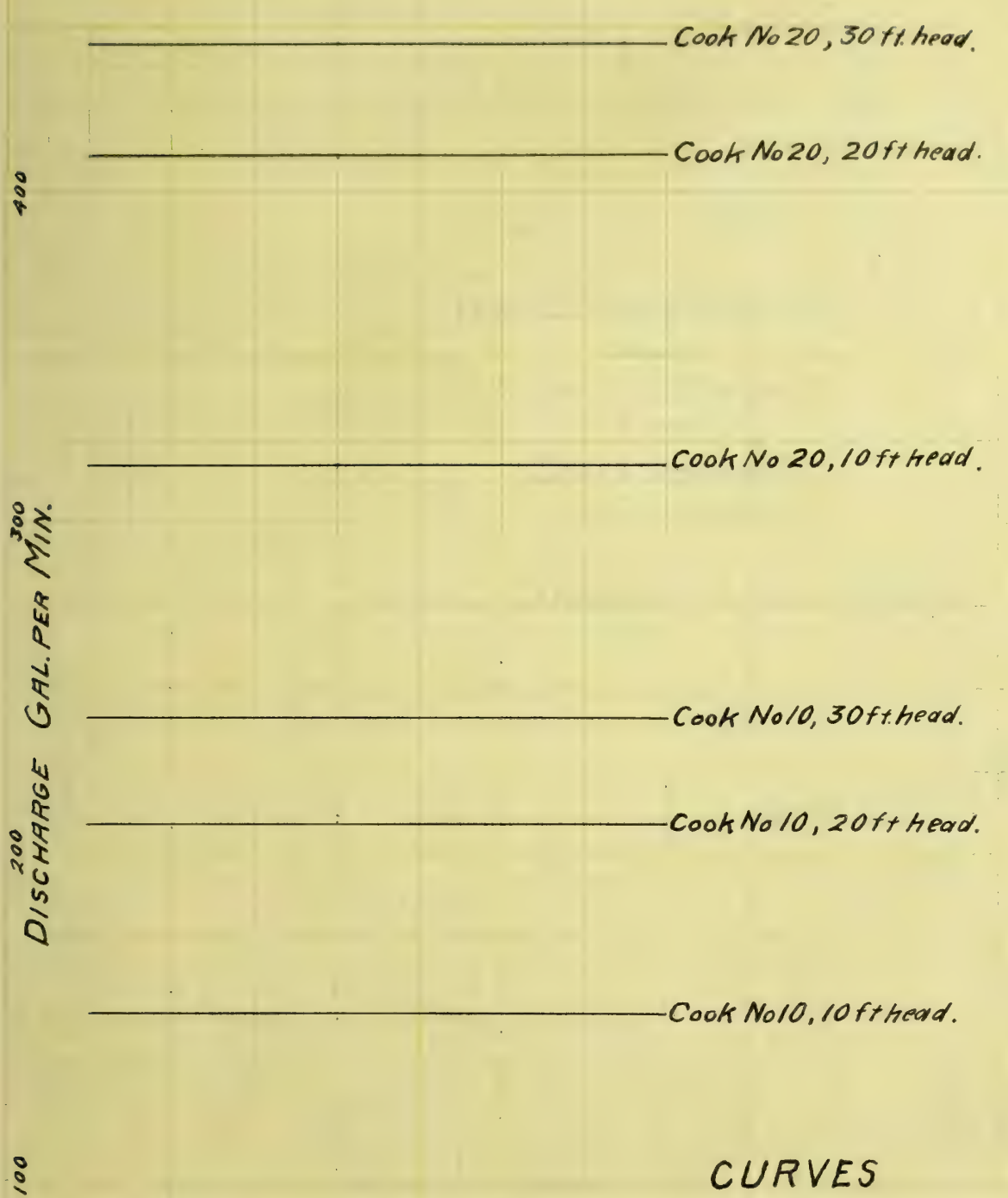


PLATE 11



CURVES

showing

AMOUNT OF DISCHARGE

FOR VARIOUS HEADS

COOK STRAINERS

WITHOUT SAND.

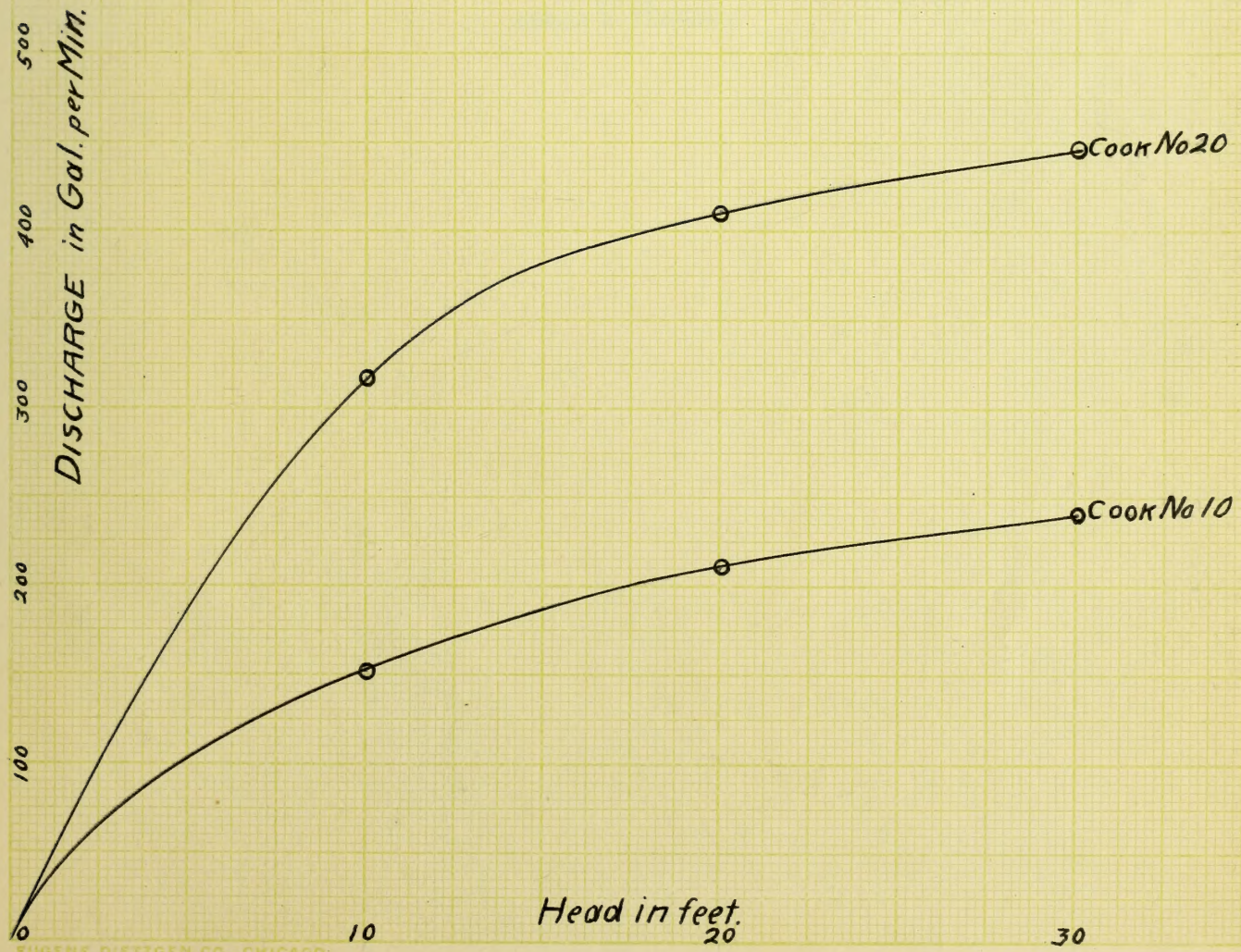
STRAINER AREA = 1.44 sq. ft.

... CHANDLER & CO., CHICAGO.

PLATE 12

CURVES showing RELATION
between
HEAD & DISCHARGE.
through
COOK'S STRAINERS
WITHOUT SAND.

STRAINER AREA = 1.44 sq. ft.



EUGENE DIETZGEN CO., CHICAGO.